

Amendments to the Claims:

This listing of claims will replace all prior versions and listing of claims in the application.

Listing of Claims:

1. (Currently Amended) A perpendicular magnetic recording medium having a perpendicular recording layer on a substrate via a soft magnetic underlayer, wherein said soft magnetic underlayer comprises:

a ferromagnetic layer made from a soft magnetic material with high magnetic moment,

a first amorphous soft magnetic layer formed directly on the ferromagnetic layer;

a second amorphous soft magnetic layer;

a non-magnetic layer which is formed between said first amorphous soft magnetic layer and said second amorphous soft magnetic layer; and

an antiferromagnetic layer formed under the ferromagnetic layer, which applies an exchange bias field to said first amorphous soft magnetic layer, and

said first amorphous soft magnetic layer and said second amorphous soft magnetic layer are antiferromagnetically coupled.

2. (Canceled)

3. (Original) A perpendicular magnetic recording medium according to Claim 1, further comprising:

a first ferromagnetic layer, between said first amorphous soft magnetic layer and said non-magnetic layer; and

a second ferromagnetic layer, between said second amorphous soft magnetic layer and said non-magnetic layer.

4. (Original) A perpendicular magnetic recording medium according to Claim 1, wherein the thickness of said first amorphous soft magnetic layer is equal to the thickness of said second amorphous soft magnetic layer.

5. (Currently Amended) A perpendicular magnetic recording medium having a perpendicular recording layer on a substrate via a soft magnetic underlayer, wherein said soft magnetic underlayer comprises:

a ferromagnetic layer made from a soft magnetic material with high magnetic moment;

a first amorphous soft magnetic layer formed directly on the ferromagnetic layer;

a second amorphous soft magnetic layer;

a first non-magnetic layer which is formed between said first amorphous soft magnetic layer and said second amorphous soft magnetic layer;

a third amorphous soft magnetic layer;

a second non-magnetic layer which is formed between said second amorphous soft magnetic layer and said third amorphous soft magnetic layer; and

an antiferromagnetic layer formed under the ferromagnetic layer, which applies an exchange bias field to said first amorphous soft magnetic layer,

said first amorphous soft magnetic layer and said second amorphous soft magnetic layer are antiferromagnetically coupled, and

said second amorphous soft magnetic layer and said third amorphous soft magnetic layer are antiferromagnetically coupled.

6. (Original) A perpendicular magnetic recording medium according to Claim 5, wherein the thickness of said second amorphous soft magnetic layer is equal to the sum of the thickness of said first amorphous soft magnetic layer and the thickness of said third amorphous soft magnetic layer.

7. (Previously Presented) A perpendicular magnetic recording medium according to Claim 1, wherein a magnetization curve of said soft magnetic underlayer measured by applying a magnetic field to said disk substrate in a radial direction is step-shaped with a magnetization level which is stable in an arbitrary magnetic field range including a zero magnetic field, and

an absolute of a center value of a switching field from saturation magnetization on a negative magnetic field side to said magnetization level is different from an absolute of a center value of a switching field from the saturation magnetization on a positive magnetic field side to the magnetization level.

8. (Currently Amended) A magnetic storage apparatus comprising:

- a perpendicular magnetic recording medium having a perpendicular recording layer on a substrate via a soft magnetic underlayer;
- a driving section which drives said perpendicular magnetic recording medium in a recording direction;
- a magnetic head having a recording section and a reproducing section;
- a unit which relatively moves said magnetic head to said perpendicular magnetic recording medium; and
- a recording/reproducing processing unit which inputs a signal from said magnetic head and reproduces an output signal from said magnetic head,

wherein said soft magnetic underlayer of said perpendicular magnetic recording medium comprises:

- a ferromagnetic layer made from a soft magnetic material with high magnetic moment;
- a first amorphous soft magnetic layer formed directly on the ferromagnetic layer;
- a second amorphous soft magnetic layer;
- a non-magnetic layer which is formed between said first amorphous soft magnetic layer and said second amorphous soft magnetic layer; and
- an antiferromagnetic layer formed under the ferromagnetic layer, which applies an exchange bias field to said first amorphous soft magnetic layer,

said first amorphous soft magnetic layer and said second amorphous soft magnetic layer are antiferromagnetically coupled,

said recording section of said magnetic head comprises a single-pole head,
and

said reproducing section of said magnetic head comprises a high-sensitive element using a magnetoresistive effect or tunneling magnetoresistive effect.

9. (Currently Amended) A magnetic storage apparatus comprising:

a perpendicular magnetic recording medium having a perpendicular recording layer on a substrate via a soft magnetic underlayer;

a driving section which drives said perpendicular magnetic recording medium in a recording direction;

a magnetic head having a recording section and a reproducing section;

a unit which relatively moves said magnetic head to said perpendicular magnetic recording medium; and

a recording/reproducing processing unit which inputs a signal from said magnetic head and reproduces an output signal from said magnetic head,

wherein said soft magnetic underlayer of said perpendicular magnetic recording medium comprises:

a ferromagnetic layer made from a soft magnetic material with high magnetic moment;

a first amorphous soft magnetic layer formed directly on the ferromagnetic layer;

a second amorphous soft magnetic layer;

a (first) non-magnetic layer which is formed between said first amorphous soft magnetic layer and said second amorphous soft magnetic layer;

a third amorphous soft magnetic layer;

a (second) non-magnetic layer which is formed between said second amorphous soft magnetic layer and said third amorphous soft magnetic layer; and

an antiferromagnetic layer formed under the ferromagnetic layer, which applies an exchange bias magnetic field to said first amorphous soft magnetic layer, said first amorphous soft magnetic layer and said second amorphous soft magnetic layer are antiferromagnetically coupled,

said second amorphous soft magnetic layer and said third amorphous soft magnetic layer are antiferromagnetically coupled,

said recording section of said magnetic head comprises a single-pole head, and

said reproducing section of said magnetic head comprises a high-sensitive element using a magnetoresistive effect or tunneling magnetoresistive effect.

10. (Currently Amended) A perpendicular magnetic recording medium having a perpendicular recording layer on a disk substrate via a soft magnetic underlayer, wherein said soft magnetic underlayer comprises:

a ferromagnetic layer made from a soft magnetic material with high magnetic moment;

a first amorphous soft magnetic layer formed directly on the ferromagnetic layer;

a second amorphous soft magnetic layer;

a non-magnetic layer which is formed between said first amorphous soft magnetic layer and said second amorphous soft magnetic layer; and

an antiferromagnetic layer formed under the ferromagnetic layer, which applies an exchange bias field to said first amorphous soft magnetic layer,

said antiferromagnetic layer contains a disordered alloy mainly composed of Fe and Mn,

the direction of said exchange bias field is substantially in parallel with said radial direction of said disk substrate, and

said first amorphous soft magnetic layer and said second amorphous soft magnetic layer are antiferromagnetically coupled.

11. (Currently Amended) A perpendicular magnetic recording medium according to Claim 10, wherein said antiferromagnetic layer is formed on a metal layer or alloy having a face-centered cubic structure containing Pd, Pt, Cu or NiFe.

12-16. Cancel.

17. (New) A perpendicular magnetic recording medium having a perpendicular recording layer on a disk substrate via a soft magnetic underlayer, wherein said soft magnetic underlayer comprises:

a ferromagnetic layer which is a body-centered cubic alloy mainly composed of Co and Fe;

a first amorphous soft magnetic layer formed directly on the ferromagnetic layer;

a second amorphous soft magnetic layer;

a non-magnetic layer which is formed between said first amorphous soft magnetic layer and said second amorphous soft magnetic layer; and

an antiferromagnetic layer formed under the ferromagnetic layer, which applies an exchange bias field to said first amorphous soft magnetic layer,

said antiferromagnetic layer contains a disordered alloy mainly composed of Fe and Mn,

the direction of said exchange bias field is substantially in parallel with said radial direction of said disk substrate, and

said first amorphous soft magnetic layer and said second amorphous soft magnetic layer are antiferromagnetically coupled